Rajshahi University of Engineering & Technology

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Course Title: Digital Signal Processing Sessional

Course No: ECE 4124

Date of Submission: 14.05.2023

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Experiment No: 03

Experiment Name: Study of Auto Correlation & Cross Correlation

Experiment Date: 07.05.2023

Theory :

Auto Correlation: In digital signal processing (DSP), autocorrelation refers to the correlation of a signal with a delayed version of itself. Autocorrelation is used to determine the similarity of a signal at different time instants, and is particularly useful in the analysis of time series data.

Autocorrelation is commonly expressed as a mathematical function, and is denoted by the symbol Rxx(k), where k is the time delay between the two signal samples being compared. The autocorrelation function is defined as:

$$Rxx(k) = E[x[n] * x[n-k]]$$

where E is the expectation operator, x(n) is the signal at time n, and k is the time delay.

Cross Correlation: Cross-correlation is a mathematical operation used in digital signal processing (DSP) to measure the similarity between two signals as a function of their relative time alignment. The cross-correlation function is used to find the time delay between two signals or to detect patterns in a noisy signal.

The cross-correlation function of two signals x[n] and y[n] is defined as:

$$Rxy(k) = E[x[n] * y[n+k]]$$

where k is the time lag and E is the expectation operator. The cross-correlation function measures the correlation between the two signals as a function of their relative time alignment. Positive values of Rxy(k) indicate that the two signals are positively correlated, while negative values indicate negative correlation.

Software: MATLAB

Code:

Auto Correlation

1. without function:

```
 clc
clear all
x=[2 2 3 1];
h=fliplr(x);
z=zeros(1,length(x)+length(h)-1);
for n=1:length(z);
   for k=1:length(h);
      if n-k+1>0 && n-k+1<=length(x);
         z(n)=z(n)+h(k).*x(n-k+1);
      end
   end
end
subplot(3,1,1);
stem(x);
title('Input signal x[n]');

subplot(3,1,2);
stem(h);
title('flipped signal h[n]');

subplot(3,1,3);
stem(z);
title('auto correlated signal');
```

2. with function:

```
clc
clear all;
x=[2 2 3 1];
y=xcorr(x);
display(y);
subplot(2,1,1);
stem(x);
title('Input signal x[n]');
subplot(2,1,2);
stem(y);
title('correlated signal using function y[n]');
```

Cross Correlation:

```
clc
clear all
x=[1 2 3 4];
y=[2 2 3 1];
h=fliplr(y);
p=xcorr(x,y);
z=zeros(1,length(x)+length(h)-1);
for n=1:length(z);
   for k=1:length(h);
      if n-k+1>0 && n-k+1<=length(x);
         z(n)=z(n)+h(k).*x(n-k+1);
      end
   end
end
subplot(4,1,1);
stem(x);
title('Input signal x[n]');

subplot(4,1,2);
stem(h);
title('Input signal h[n]');

subplot(4,1,3);
stem(z);
title('crosscorrelated signal z[n]');

subplot(4,1,4);
stem(p);
title('checking of crosscorrelated signal');
```

Output :

Auto Correlation without using function:

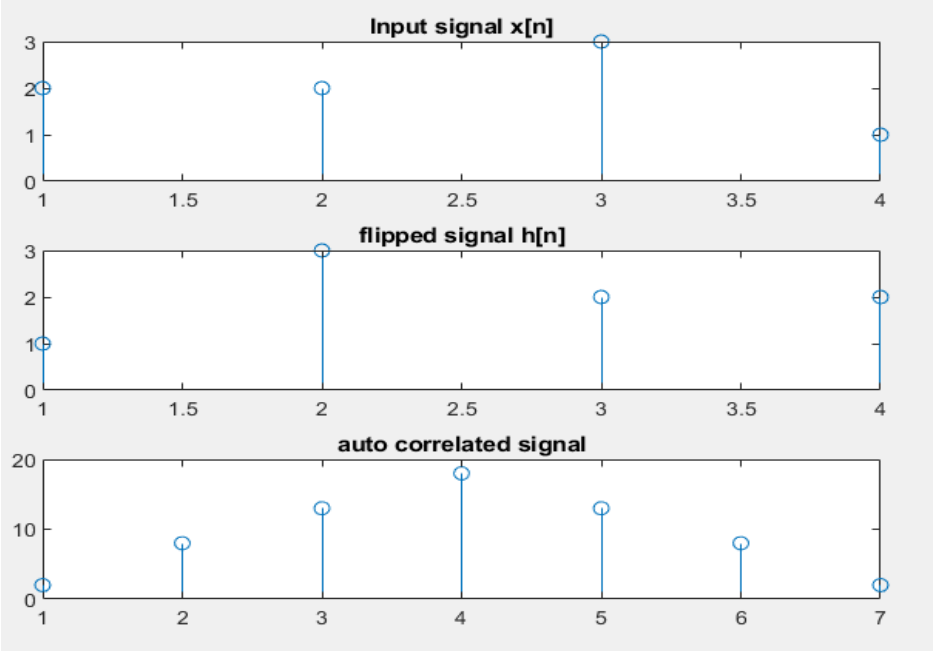

Fig 3.1 Auto Correlation

Auto Correlation without using function:

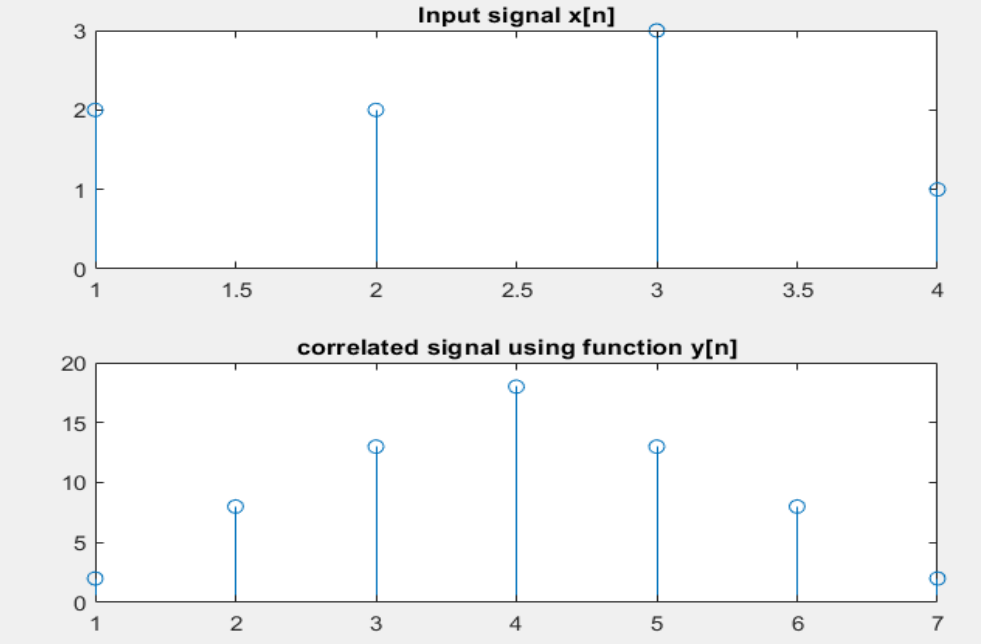

Fig 3.2 Auto Correlation using function

Cross Correlation:

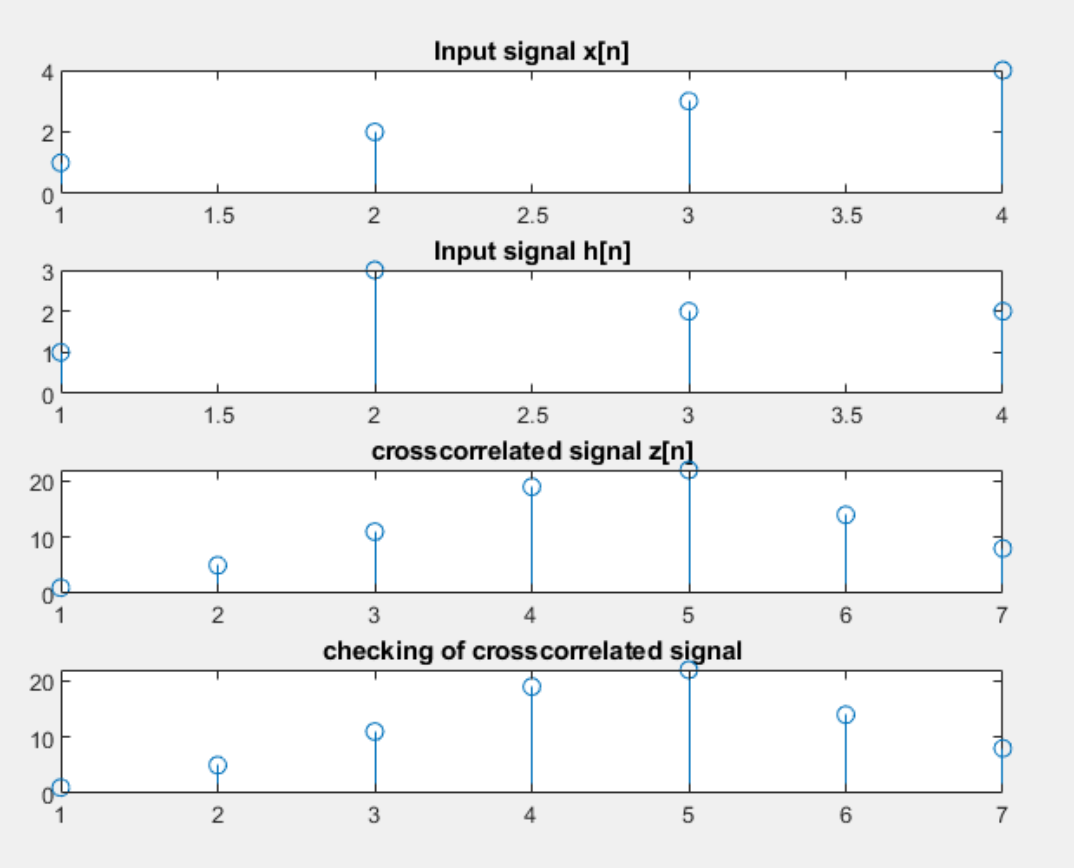

Fig 3.3 Cross Correlation

Discussion : By this experiment, we learned how to sort auto correlation and cross correlation with and without using function in MATLAB.1stly, we sorted the auto correlation and checked out the correlated answer by using 'xcorr' function to implement correlation in MATLAB.; After that, we coded cross correlation manually as like auto correlation

Conclusion :. The codes were running successfully .We ensured the answers by checking out the result using function.The codes worked as intended and were executed without any errors. So, we can come to a conclusion that the experiments were done perfectly..